Land Subsidence Reversal and Carbon Sequestration in a Restored Wetland on Twitchell Island, Sacramento-San Joaquin Delta, California

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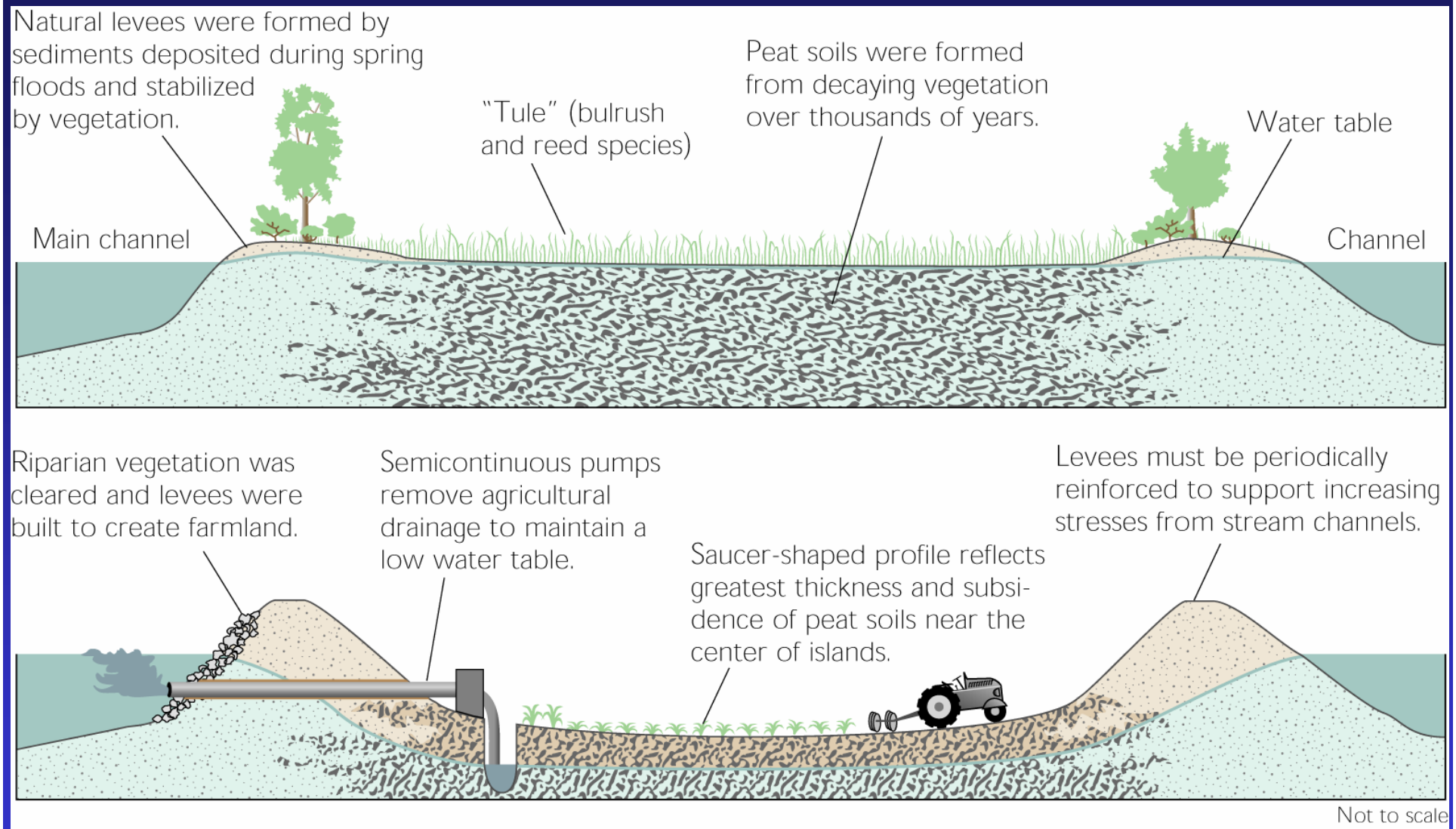
and many others

Coop Study between the U.S. Geological Survey's CA Water Science Center and the CA Department of Water Resources


Natural levees were formed by sediments deposited during spring floods and stabilized by vegetation.
"Tule" (bulrush and reed species)
Peat soils were formed from decaying vegetation over thousands of years.
Water table
Main channel
Channel
Riparian vegetation was cleared and levees were built to create farmland.
Semicontinuous pumps remove agricultural drainage to maintain a low water table.
Saucer-shaped profile reflects greatest thickness and subsidence of peat soils near the center of islands.
Levees must be periodically reinforced to support increasing stresses from stream channels.
Not to scale

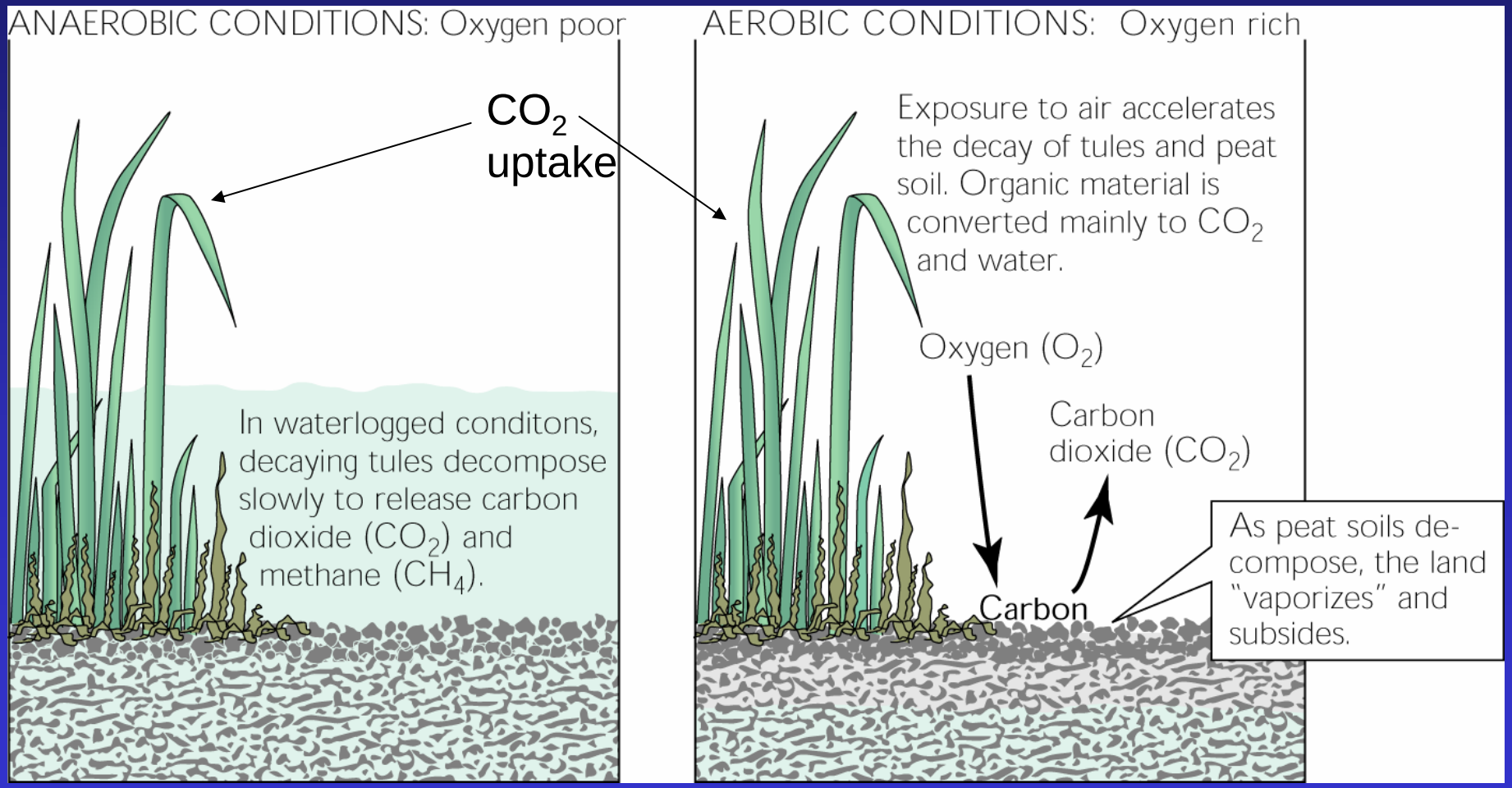
USGS

Carbon Sequestration

C input > C loss

Subsidence

(C loss > C input)



USGS

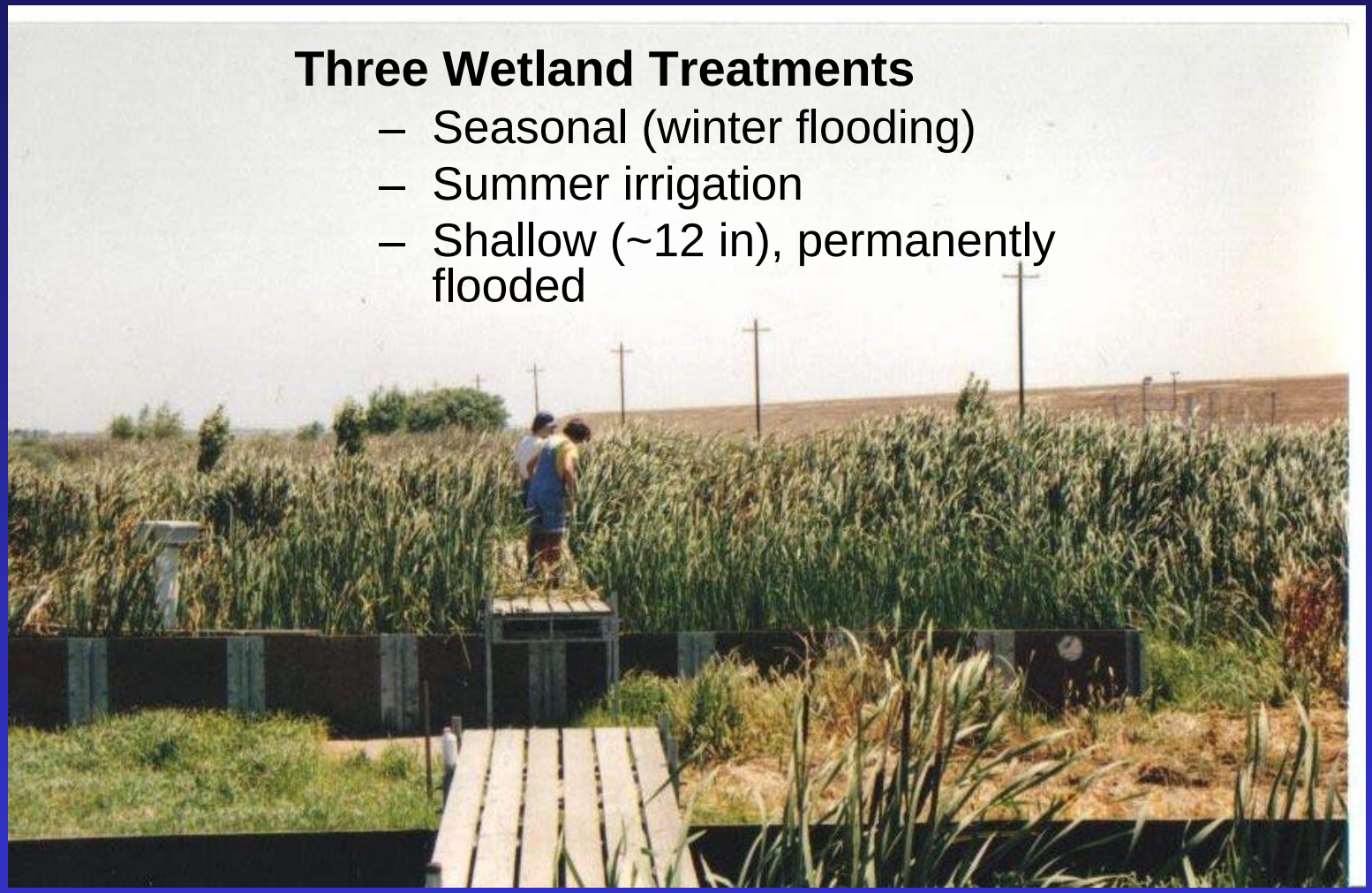
Subsidence
(land surface elevation decline)

- **Greatest subsidence in Central and Western Delta**
- **Subsidence as great as 25 ft below sea level**

How can we reverse Subsidence?

USGS

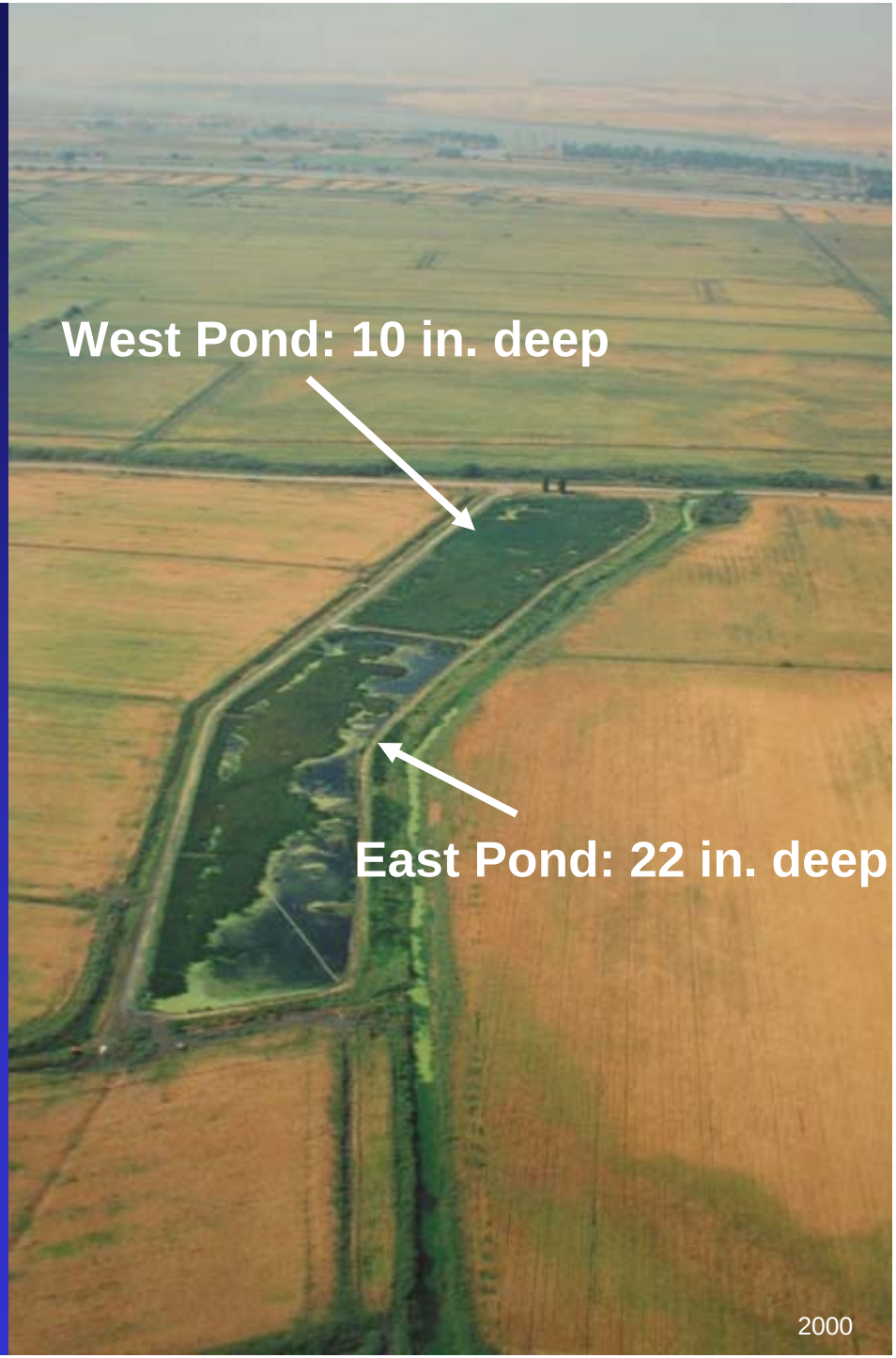
Small Ponds Pilot Project 1993-1997



Shallow, permanent flooding worked best to Reverse Subsidence through Plant Growth

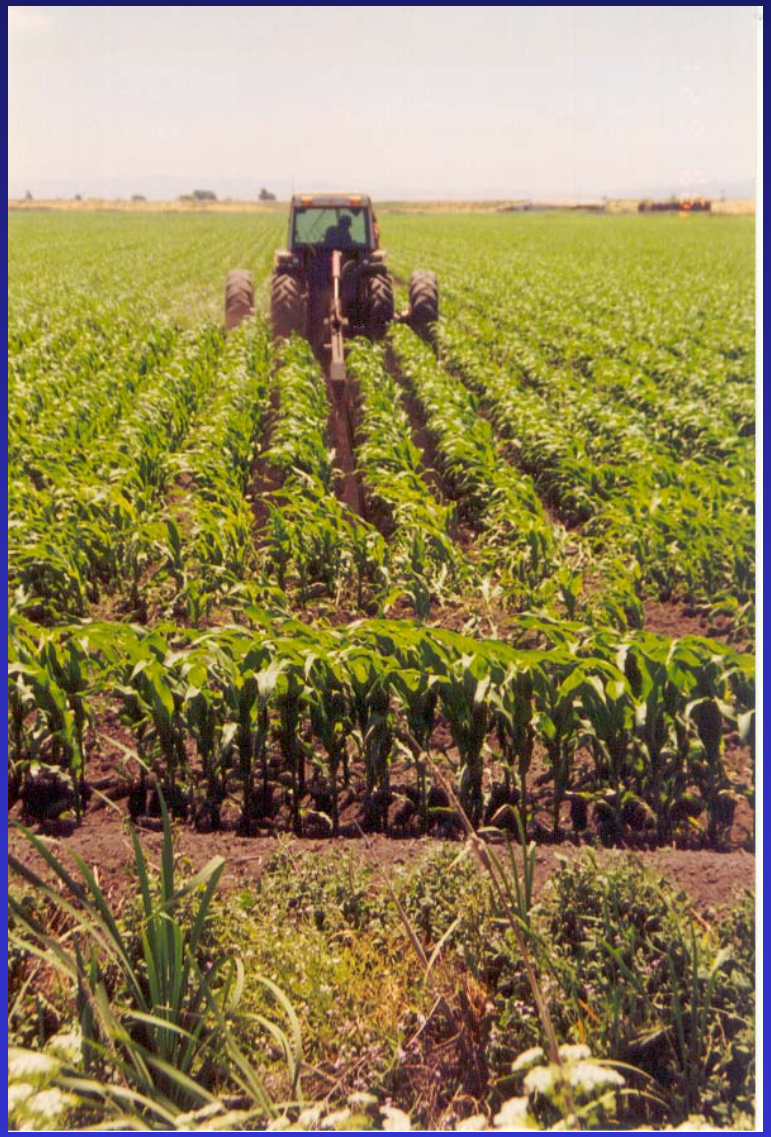
Twitchell Island Demonstration Project 1997-present

- Two 7½ acre wetlands
- Continuously flooded
- Non-tidal system



USGS

Current agricultural practices promote losses of carbon (CO_2) from the soil



- **This causes high rates of subsidence**
- **And contributes to greenhouse gas emissions**

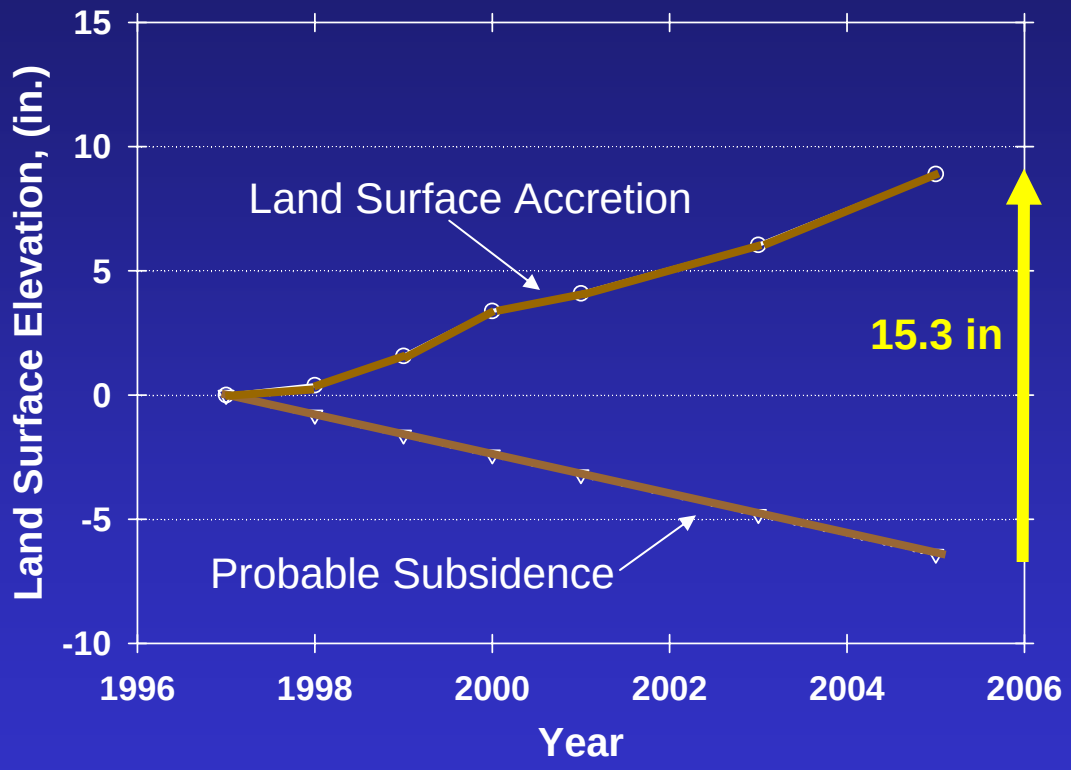
Permanently flooded wetlands reduce/stop emissions of carbon (CO_2) from the soil

- **This reverses subsidence**
- **And decreases greenhouse gas emissions**

Permanently flooded (shallow) wetlands promote sequestration of carbon (carbon fixed by vegetation: photosynthesis)

Plant material accumulates and raises the land surface (reverses subsidence)

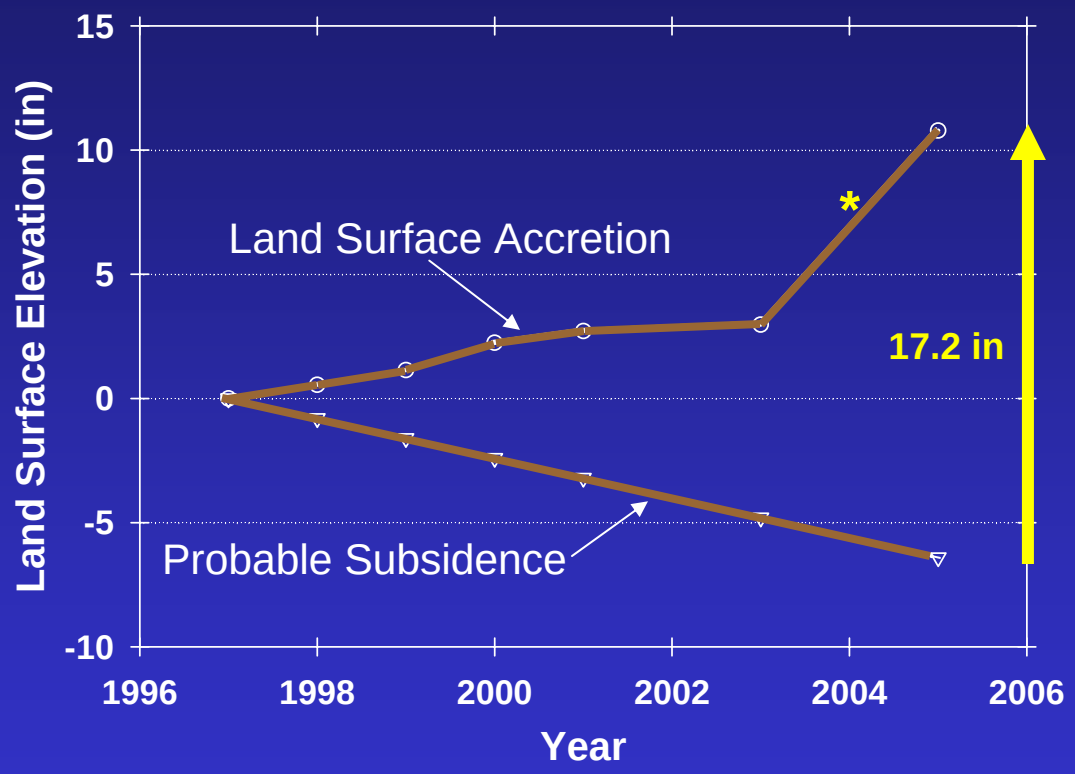
West Wetland, Land Surface Elevation



15.3 inches / 8 years = 1.9 inches/year

USGS

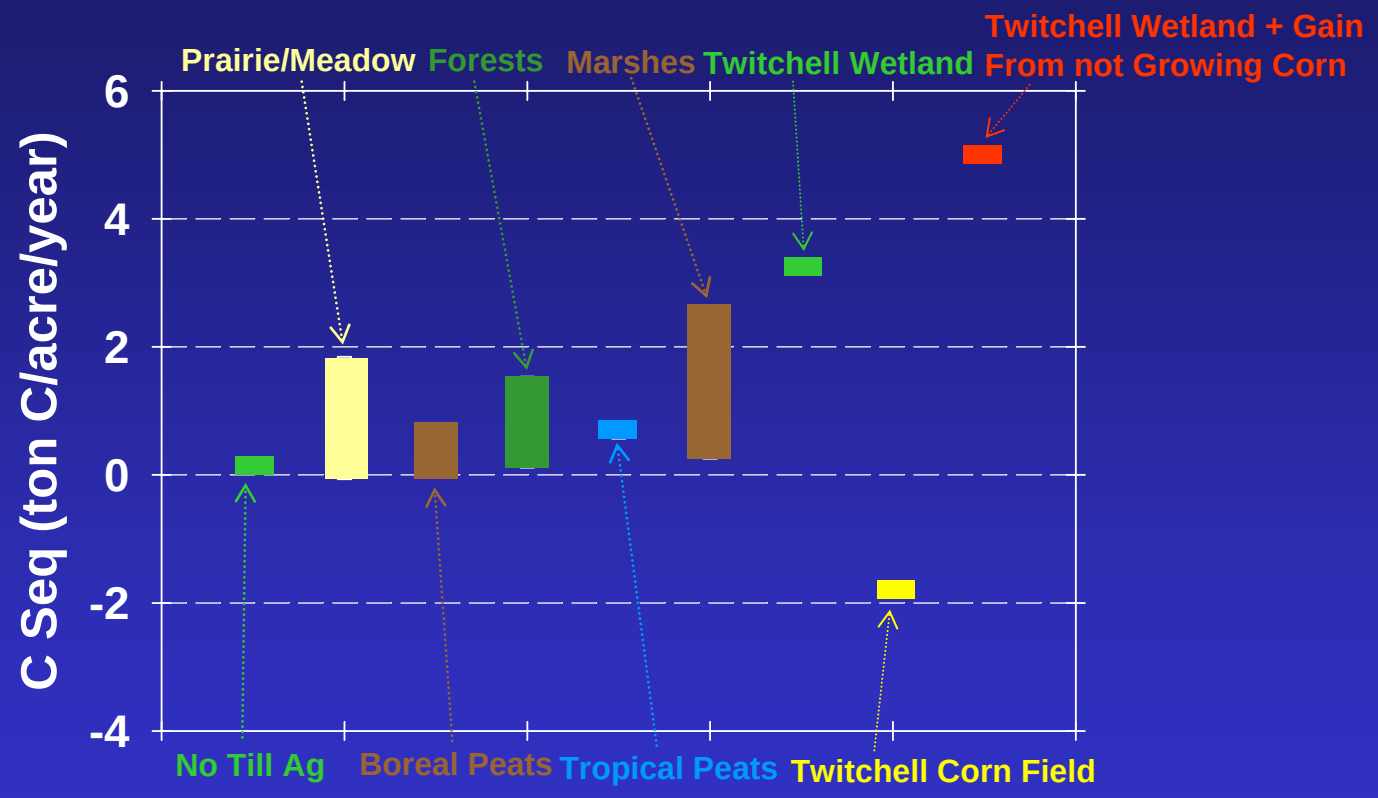
East Wetland, Land Surface Elevation



17.2 inches / 8 years = 2.15 inches/year

*** 2003 - 2005: 3.9 inches/year**

Carbon Sequestration for Different Land Uses



Major Conclusions

- Managed, restored wetlands can mitigate and reverse land subsidence on subsided Delta islands
- The dominant emergent marsh vegetation (cattails and tules) making up these wetlands sequesters much greater amounts of carbon than other land uses (forests, marshes, etc.)

Where do we go from here?

- Some major uncertainties that need to be looked into
  - Dissolved organic matter, potential drinking water concern: Precursors of Disinfection Byproducts
  - Potential for mercury methylation in wetlands: Concerns for the Delta foodweb and Consumers of Fish

Where do we go from here?

- Farm-scale demonstration of Managed Wetland Restoration for Carbon Sequestration and Subsidence Reversal